Technical Report Documentation Page

1. REPORT No.

2. GOVERNMENT ACCESSION No.

3. RECIPIENT'S CATALOG No.

4. TITLE AND SUBTITLE

A Survey Of Earth-Borne Vibration North American- Rockwell Facility At Downey

5. REPORT DATE

March 1969

6. PERFORMING ORGANIZATION

7. AUTHOR(S)

E.F. Nordlin

8. PERFORMING ORGANIZATION REPORT No.

9. PERFORMING ORGANIZATION NAME AND ADDRESS

State of California
Transportation Agency
Department of Public Works
Division of Highways
Materials and Research Department

10. WORK UNIT No.

11. CONTRACT OR GRANT No.

12. SPONSORING AGENCY NAME AND ADDRESS

13. TYPE OF REPORT & PERIOD COVERED

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

I. Introduction

In response to the letter dated October 16, 1968, from Mr. K.E. McKean, District 07 Assistant District Engineer, the Materials and Research Department conducted an earth-borne vibration survey on October 29-31, 1968, at the North American Rockwell, Inc. (NAR)- Downey facility and in the greater Los Angeles area. This survey was conducted because of the expressed concern by NAR that the proposed 07-LA-105, Rt. 15.3/R18.5 Century Freeway alignment approaching within 130 feet of the south wall of Building No. 4 (Figure 1) would adversely affect their work inside of the building because of earth-borne traffic and construction vibrations. In the northwest corner area of Building No. 4 is located the metrology laboratory which NAR believes is particularly susceptible to vibrations. the proposed freeway alignment would be about 450 feet south of the metrology laboratory.

During a meeting held on December 26, 1968, between representatives of the California Division of Highways and NAR, Messrs. L. Spitler and P. Joeschke of NAR indicated that any increase in background vibrations in their metrology laboratory attributable to the proposed Century Freeway alignment would be an intolerable condition for their operations. They would not state specifically the vibration level that their laboratory could tolerate; only that their future operations may require a degree of freedom from vibrations which they cannot even estimate at this time.

17. KEYWORDS

18. No. OF PAGES:

30

19. DRI WEBSITE LINK

http://www.dot.ca.gov/hq/research/researchreports/1969-1970/69-17.pdf

20. FILE NAME

69-17.pdf

STATE OF CALIFORNIA
TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

A SURVEY OF EARTH-BORNE VIBRATIONS NORTH AMERICAN - ROCKWELL FACILITY AT DOWNEY

69-17

MARCH 1969

MATERIALS & RESEARCH DEPARTMENT

STATE OF CALIFORNIA—TRANSPORTATION AGENCY
RONALD REAGAN, Governor

DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS
MATERIALS AND RESEARCH DEPARTMENT
5900 FOLSOM BLVD., SACRAMENTO 95819

March 14, 1969

Project 36445

Mr. H. Ayanian
District Engineer
District 07
Division of Highways
Los Angeles, California

Dear Sir:

Submitted for your consideration is a report entitled:

A SURVEY OF EARTH-BORNE VIBRATIONS

AT

NORTH AMERICAN-ROCKWELL DOWNEY FACILITY

E. F. NORDLIN
Principal Investigator

L. G. Kubel and W. Chow
Co-Investigators

Very truly yours,

JOHN L. BEATON
Materials and Research Engineer

Attach.

I. INTRODUCTION

In response to the letter dated October 16, 1968, from Mr. K. E. McKean, District 07 Assistant District Engineer, the Materials and Research Department conducted an earth-borne vibration survey on October 29-31, 1968, at the North American Rockwell, Inc. (NAR) - Downey facility and in the greater Los Angeles area. This survey was conducted because of the expressed concern by NAR that the proposed 07-LA-105, Rt. 15.3/R18.5 Century Freeway alignment approaching within 130 feet of the south wall of Building No. 4 (Figure 1) would adversely affect their work inside of the building because of earth-borne traffic and construction vibrations. In the northwest corner area of Building No. 4 is located the metrology laboratory which NAR believes is particularly susceptible to vibrations. The proposed freeway alignment would be about 450 feet south of the metrology laboratory.

During a meeting held on December 26, 1968, between representatives of the California Division of Highways and NAR, Messrs. L. Spitler and P. Joeschke of NAR indicated that any increase in background vibrations in their metrology laboratory attributable to the proposed Century Freeway alignment would be an intolerable condition for their operations. They would not state specifically the vibration level that their laboratory could tolerate; only that their future operations may require a degree of freedom from vibrations which they cannot even estimate at this time.

II. CONCLUSIONS AND SUMMARY

In summary, the proposed alignment of Route 105 within the above described distances to the NAR Building No. 4 would not significantly increase their present in-plant vibrations for the following reasons:

1. The 450 ft. distance separating the metrology laboratory and the proposed freeway alignment will attenuate freeway earth-borne vibrations to such a low level as to not contribute to any increase in quiescent background vibrations in the metrology laboratory. This conclusion is the result of measurements made during truck crane passage Run No. 6.

2. Continuous vibrations on the NAR mezzanine floor (2900 microinches) were larger than the vibrations (1360 microinches) measured directly beneath the Santa Monica Viaduct and larger than any freeway earth-borne vibrations measured by this department over a ten year period. Furthermore, within a 64 ft. distance normal from the Santa Monica Viaduct, earth-borne vibrations had decreased to 130 microinches. Within 450 ft., the distance between the proposed freeway alignment and the metrology laboratory, earth-borne vibrations emanating from the proposed freeway will have decreased to such a level that it will not significantly raise the metrology area quiescent background vibration level.

3. Continuous vibrations on the NAR mezzanine floor were 10 times larger than the earth-borne vibrations emanating from highway construction equipment at a 150 ft. distance.

   Furthermore, at this distance the earth-borne vibrations induced by construction equipment were only about twice as large as the metrology hallway floor background quiescent vibrations. Further vibration attenuation can be expected in a 450 ft. distance.

4. Continuous vibrations on the NAR mezzanine floor were 10 times larger than measured on the metrology hallway floor during passages of a truck crane driven along the outside of Building No. 4.

5. Imperial Highway earth-borne traffic vibrations attenuated, at a 55 ft. distance, to 90 microinches. This is almost equal to the NAR metrology hallway floor quiescent vibration of 70 microinches. Therefore, the proposed freeway alignment at a distance of 450 ft. from the metrology laboratory will further attenuate the earth-borne vibrations in that distance to a level which would not raise the metrology laboratory floor quiescent vibration level.

6. The street curb of Clark Avenue is within 90 ft. of the metrology laboratory. It is significant that the proposed freeway alignment at a distance of 450 ft. will be 5 times further away from the laboratory. It can be expected that earth-borne vibrations from the proposed freeway attenuated over a 450 ft. distance would not be significantly larger at the metrology laboratory than the Clark Avenue traffic vibrations.

It would seem reasonable that since NAR has tolerated their own in-plant vibrations and adjacent city street traffic vibrations the low level of vibrations that could emanate from construction of the proposed freeway and finished freeway traffic would not cause an intolerable condition for them.

III. TEST PROCEDURE

The test procedure consisted of recording earth-borne vibrations appearing on the floor of NAR's metrology laboratory (see Figure 2) created by a truck crane driven around the outside of the building; recording NAR's present in-plant vibrations; recording vibrations due to Imperial Highway street traffic (see Figure 3) next to NAR's building; recording vibrations emanating from normal freeway embankment construction operations and recording vibrations emanating from traffic on a freeway viaduct.

The vibration recording instrument used is shown in Figure 4. It consisted of two Teledyne Earth Science Ranger Seismometers models SD-214, serial numbers 144 and 148; a Teledyne model SC201 signal conditioner and a Brush oscillograph. The vibration instrumentation system has a sensitivity of approximately 10 microinches at 1.0 HZ. This instrumentation system was designed by the Teledyne Company especially for earth-borne vibration measurements and acquired by the California Division of Highways in 1966. The Division of Highways personnel who conducted this survey are experienced and well-versed in the operation of this equipment.

IV. DISCUSSION

The Materials and Research Department, over a ten year period, has made many studies of earth-borne vibrations affecting private homes, manufacturing plants, and an art museum.

Test data from these studies have indicated that earth-borne traffic and construction vibrations were usually insignificant 100 feet from the freeway or vibration source and, if measurable, would be very small in magnitude. If was felt that the present vibration complainant's claim would be no different.

However, due to the sophistication of the physical measurements performed by NAR's metrology laboratory and because the proposed freeway pavement edge would be 130 feet from NAR's Building No. 4, it was felt desirable to conduct a vibration survey in order to evaluate NAR's concern.

Figure 5 is a bar graph summary of vibration data recorded during the Materials and Research Department survey. The survey consisted of 68 vibration recordings but only the largest vibration from each of the particular locations is graphed in Figure 5. The actual vibration recordings from the runs which are bar graphed in Figure 5 are attached to this report and arranged in ascending order of run numbers (Figures 6 through 23). Each run number is listed below its respective graphed bar in Figure 5.

Block 1 in Figure 5 shows the four background quiescent vibrations recorded at the four indicated locations. Quiescent vibrations are those vibrations recorded during a "quiet" vibration period where no known vibratory machinery, vehicles or vibration sources are in operation. These four "quiet" periods served to establish a reference from which to form a criteria. It is also apparent that no lower background vibrations can be expected at a given location than during a "quiet" period. The four "quiet" vibration recordings are Run Nos. 10, 15A, 61, 41, and shown in Figures 13, 15, 22, and 18.

The background vibrations on the NAR metrology hallway floor in Building No. 4 (see Figure 2 for location) was 70 micro-inches at an approximate frequency of 0.2 - 0.4 HZ (cycles/second). This slow floor movement may actually be the building or ground tilting in response to outside vehicle traffic, motorized tow trucks driven throughout the NAR hallways or other myriad moving loads in and about the NAR building. The other three quiescent vibration recordings indicate that a range of 90 - 140 microinches of "quiet" background vibrations can be expected in the greater Los Angeles area in geological formation similar to the NAR Downey area.

Block 2 in Figure 5 shows the vibration results from the survey conducted in and around the NAR facility. NAR supplied a 3 axle, 65,000 lb., 50 ton capacity truck crane which was driven around the outside of their Building No. 4 to create vibrations. The resultant earth-borne vibrations appearing on the NAR metrology hallway during these truck crane passages were recorded by the California Division of Highways seismometer system. NAR also set up their own seismometer system so that the vibrations resulting from the crane passage could be recorded on their system. Figures 6, 7, 8, 9, and 10 are the actual Materials and Research Department vibration recordings for these truck crane passages next to the building. The maximum hallway vibration for each of these passages are graphed in Block 2 of Figure 5 as Bars 1 through 5. Examination of these results shows that the largest hallway vibration, 260 microinches at 2.0 and 2.6 HZ, resulted from the truck crane passage of Run Nos. 1 and 2 (see Figure 2 for run locations). For these two runs the truck crane was driven within 20 feet normal to and alongside of the north metrology wall. It is of interest to note that the above vibrations were only about twice as large as the background quiescent vibration level in the Los Angeles area. For Run No. 6 (Figures 2 and 10) the truck crane was driven parallel to the south wall and at a normal distance of 170 feet from it. This distance placed the truck where the freeway pavement would be and the earth-borne vibrations which would emanate from that distance. For this run the vibrations appearing on the metrology hall floor was 88 microinches. As previously stated, the quiescent level of the hallway floor was measured to be 70 microinches. Therefore, the vibrations emanating from the truck crane passage at the proposed freeway distance was almost completely attenuated by the time it reached the hallway. The slight increase in quiescent background vibrations (from 70 to 88 microinches) may in actuality be due to other vibration sources within the building.

For a tangible and down-to-earth comparison of a vibration magnitude that the average person can understand, vibrations resulting from slamming a door shut in the metrology hallway and stomping of a foot in the hallway were recorded. This resulted in 110 microinches of displacement at 1 HZ for the slammed door and 90 microinches of displacement at 10 HZ for the foot stomping. These recordings (Bars 6 and 7 in Block 2 of Figure 5) are shown in Figures 11 and 12. It is noted that these normal "people" activities in the metrology hallway produced vibrations of about the same magnitude as that found in Run No. 3 of the truck crane passage (130 microinches at 2.2 HZ) and about one-half as large as the largest vibration (260 microinches at 2.6 HZ) produced in Run No. 1. Therefore, normal "people" activity inside of Building No. 4 can produce vibrations approaching the magnitude of a truck passage; however, it is realized that "people" activity is under NAR's own control.

The largest vibration recorded in the NAR building was on the concrete mezzanine floor (see Figure 2 for location) in the air conditioning machinery loft. The loft concrete floor area is approximately 40' x 100'. The entire floor area was vibrating to such degree from the operating air conditioning machinery that the unaided human senses can feel it. The seismometer recorded 2900 microinches of displacement at a frequency of 7.5 HZ. Mr. Spitler of NAR stated that the air conditioning machinery would never be shut down because of the conditioned air required by their computer center. This 2900 microinches of vibration displacement is about 10 times larger than that created by the previously described truck crane passages around the outside of the building. It is significant that NAR's metrology function has operated with such a large vibration source within the same building because this continuous source of vibrational energy must be dissipated somewhere, i.e., walls, floors, ground, etc. Figure 14 is the recording for this floor vibration which is also plotted as Bar 8 in Block 2 of Figure 5.

Since the NAR facility "fronts" on Imperial Highway which is a heavily traveled street, it was of interest to measure the magnitude of earth-borne vibrations emanating from it. Block 2 (Bars 9 and 10) of Figure 5 indicates that 5 feet from the Imperial Highway curb line the traffic induced earth-borne vibrations were 1040 microinches of displacement and had diminished to 90 microinches of displacement at a distance of 55 feet. These vibration recordings are shown in Figure 16. It is of interest to note that this 90 microinches of displacement, attributed to Imperial Highway traffic vibration, was the same level as recorded in Block 1 (Bar 2) of Figure 5 during a quiescent period at the same location. The significance of this finding is that the earth-borne vibrations emanating from Imperial Highway vehicular traffic was attenuated to an insignificant value within a 55 foot distance. Therefore, the 90 microinches recorded during vehicular passages on Imperial Highway at a 55 foot distance is actually the quiescent level at this distance and similar in value to that recorded in Bar 2 of Block 1.

In order to predict the amount of vibration that would emanate from the vehicular use of the proposed freeway adjacent to NAR's facilities, a vibration survey was conducted in the area of the Santa Monica Freeway at 1615 South Wall Street. This location was chosen for the vibration survey because of its similarity to the proposed freeway adjacent to NAR, i.e., elevated viaduct design, similar grade and soil condition. Block 3 (Bars 1 and 2) indicates that the maximum vibration directly beneath the Santa Monica Freeway was 1360 microinches and had diminished to 130 microinches in a distance of 64 feet. It is reasonable to assume that the vibrations would have attenuated even more at a distance of 130 feet from the freeway structure. However, vibration recordings were not made at this distance because of the masking effects of local vehicular street traffic. Nevertheless, the data indicates that the large vibration beneath the freeway had diminished more than 10 times within a distance of 64 feet from the freeway and most certainly would have diminished in 130 feet to the lower quiescent levels shown in Block 1.

What magnitude of earth-borne vibrations would emanate from the construction of the proposed freeway adjacent to NAR? To answer this question, several on-going freeway construction projects involving structural designs and construction methods similar to the proposed freeway adjacent to NAR were selected for vibration measurements.

Portions of the proposed freeway adjacent to NAR may be elevated earth embankment construction. Therefore, earth-borne vibrations emanating from a Caterpillar earth mover model 651 with 52 tons and 44 yards capacity were recorded. This recording was made on on-going embankment construction for the Pomona Freeway in the vicinity of Diamond Bar. The seismometer was located on the earth embankment and 150 feet away from the passage of the loaded Caterpillar 651. The earth-borne vibration emanating from its passage was 280 microinches at 15 HZ as shown in Block 3 (Bar 3) of Figure 5. Figure 19 is the actual vibration recording.

It was of paramount interest to know the magnitude of earth-borne vibrations that would emanate into an area outside of the actual embankment construction such as the situation will be at NAR. For this setup, the seismometer was placed on a residence lawn 150 feet away from and off the above-mentioned earth embankment. Passage of a Caterpillar model 651 earth mover along the outer edge of the fill created 170 microinches of vibration at 10 HZ. This vibration is graphed on Block 3, Bar 4 of Figure 5 and the actual recording is shown in Figure 20.

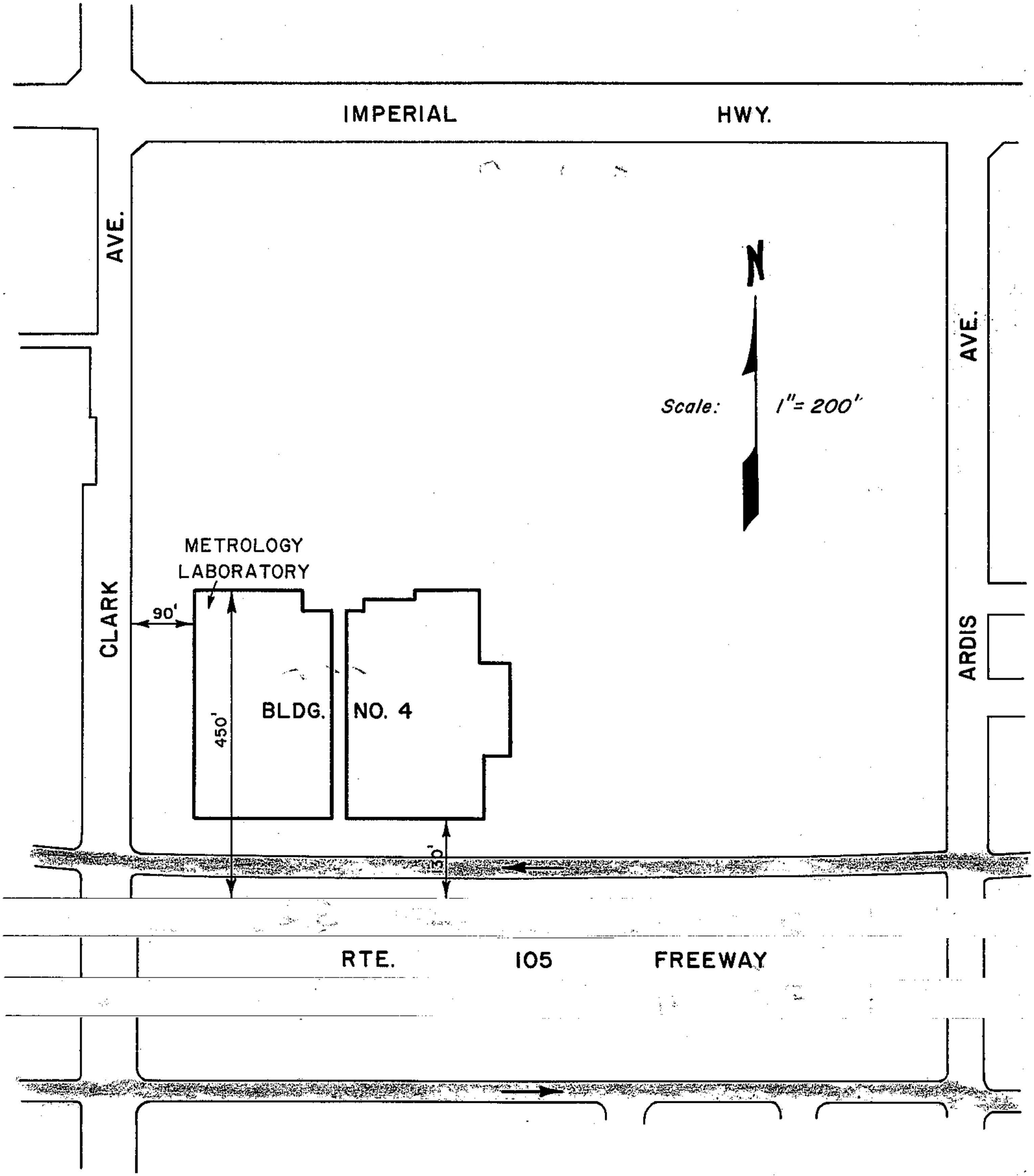
Vibrations were also recorded emanating from the passage of a Euclid E-50 40-yard earth mover traveling at city street level. The recording was made in the vicinity of Sylmar during the on-going construction of the Foothill Freeway. Block 3 (Bar 6) of Figure 5 indicates that the Euclid passage created 220 microinches of vibration displacement at a distance of 150 feet. Figure 23 is the vibration record for this run.

Because a portion of the proposed Century Freeway adjacent to NAR may be an elevated viaduct which would require foundation piles, earth-borne vibrations emanating from the drilling of several pile holes were recorded. These recordings took place at the Pomona Freeway construction in the vicinity of Diamond Bar. The largest vibrations recorded were 200 microinches at a distance of 140 feet as indicated in Block 3 (Bar 5) of Figure 5. The pile hole was being drilled with an 18" auger bit. The vibration recording is shown in Figure 21.

The above survey of earth-borne vibrations emanating from freeway construction indicates that at a distance of 140 feet vibrations in the order of 170 - 280 microinches can be expected. However, it is noted that NAR's mezzanine floor vibrated 2900 microinches which is 10 times larger than that emanating from freeway construction. Furthermore, the level of freeway construction vibration is only twice as large as the quiescent background vibration in the Los Angeles vicinity. Figure 24 lists the chart speed and calibration data for each of the vibration recordings.

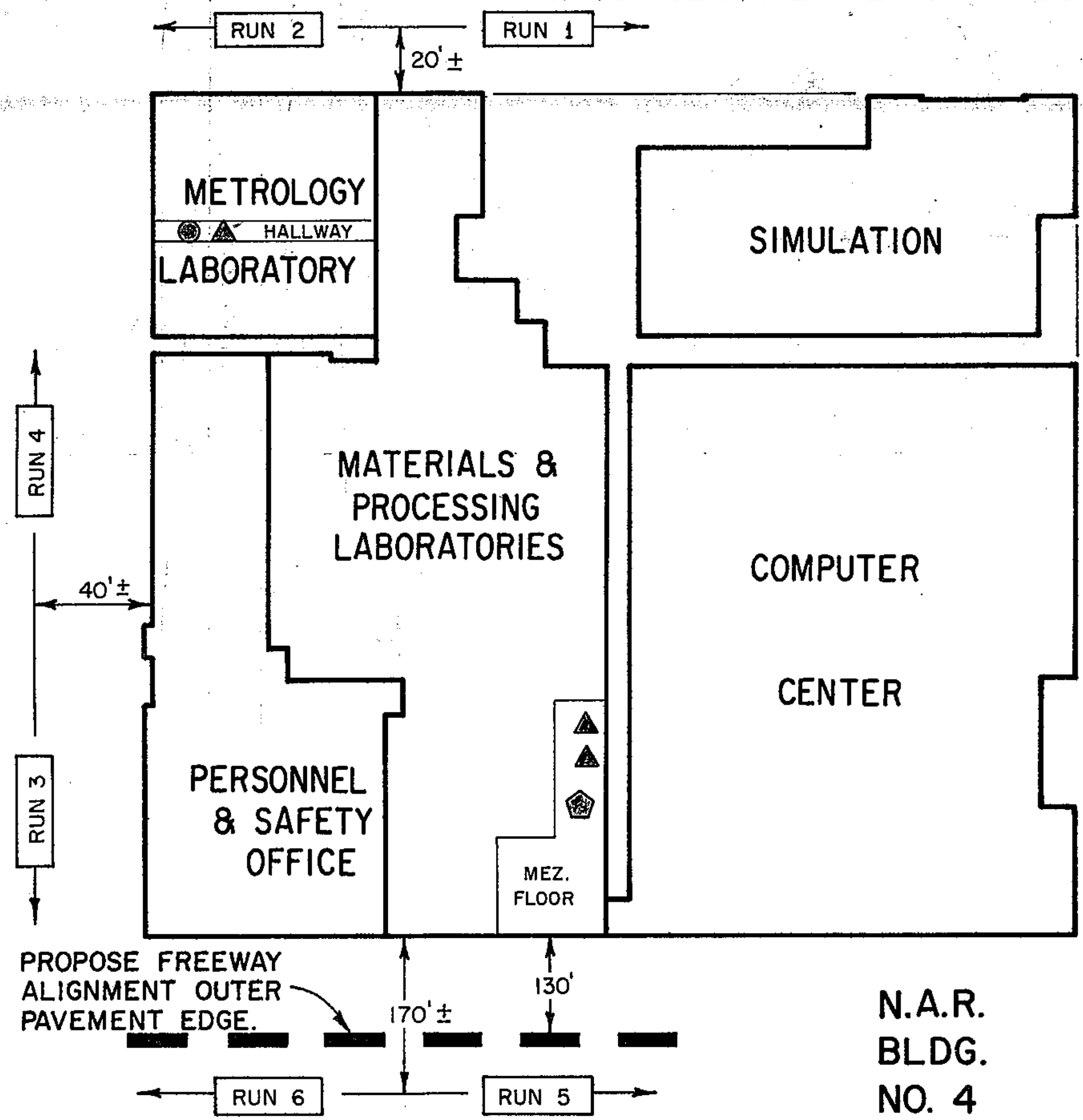
Figure 1

VIBRATION SURVEY AT NORTH AMERICAN ROCKWELL FACILITY
RTE. 105 - CENTRAL AVE. TO RTE. 605



VIBRATION SURVEY AT NORTH AMERICAN - ROCKWELL FACILITY
RT. 105 - CENTRAL AVE TO RT. 605

Run	DISPLACEMENT Inches, P-P	Hz
1	0.000260	2.6
2	0.000260	2.0
3	0.000130	2.2
4	0.000176	2.6
5	—	–
6	0.000088	2.5



Division of Highways Seismometer setup.

North American Seismometer setup.

Air conditioning machinery room on mezzanine floor (S348 - W21)

Truck crane: 3 axle, 50 ton capacity, 65,000 lbs. wt. of crane.

No Scale

N.A.R.
BLDG.
NO. 4

Figure 2

Figure 3

VIBRATION SURVEY AT NORTH AMERICAN - ROCKWELL FACILITY

RT. 105 - CENTRAL AVE TO RT. 605

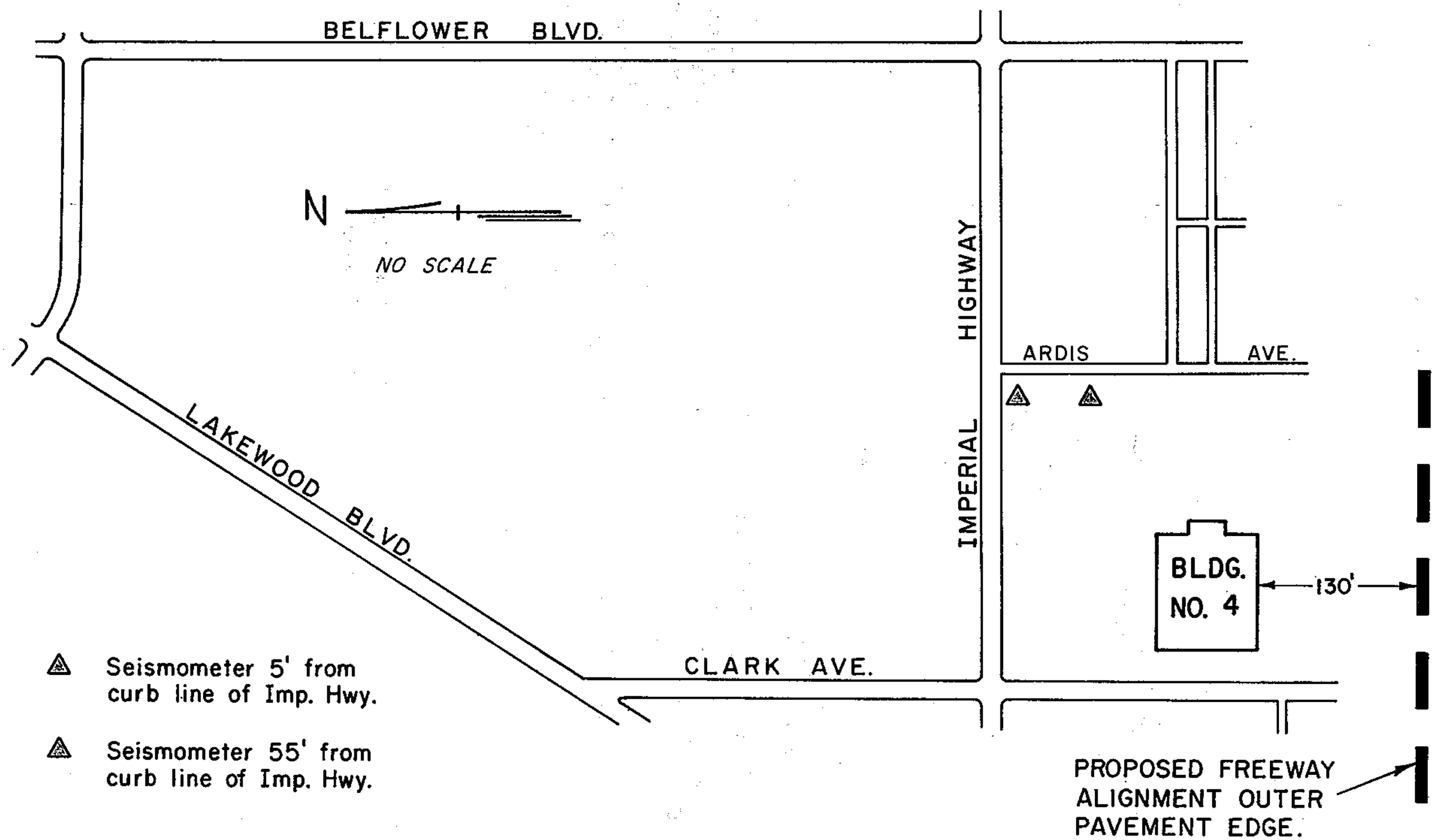
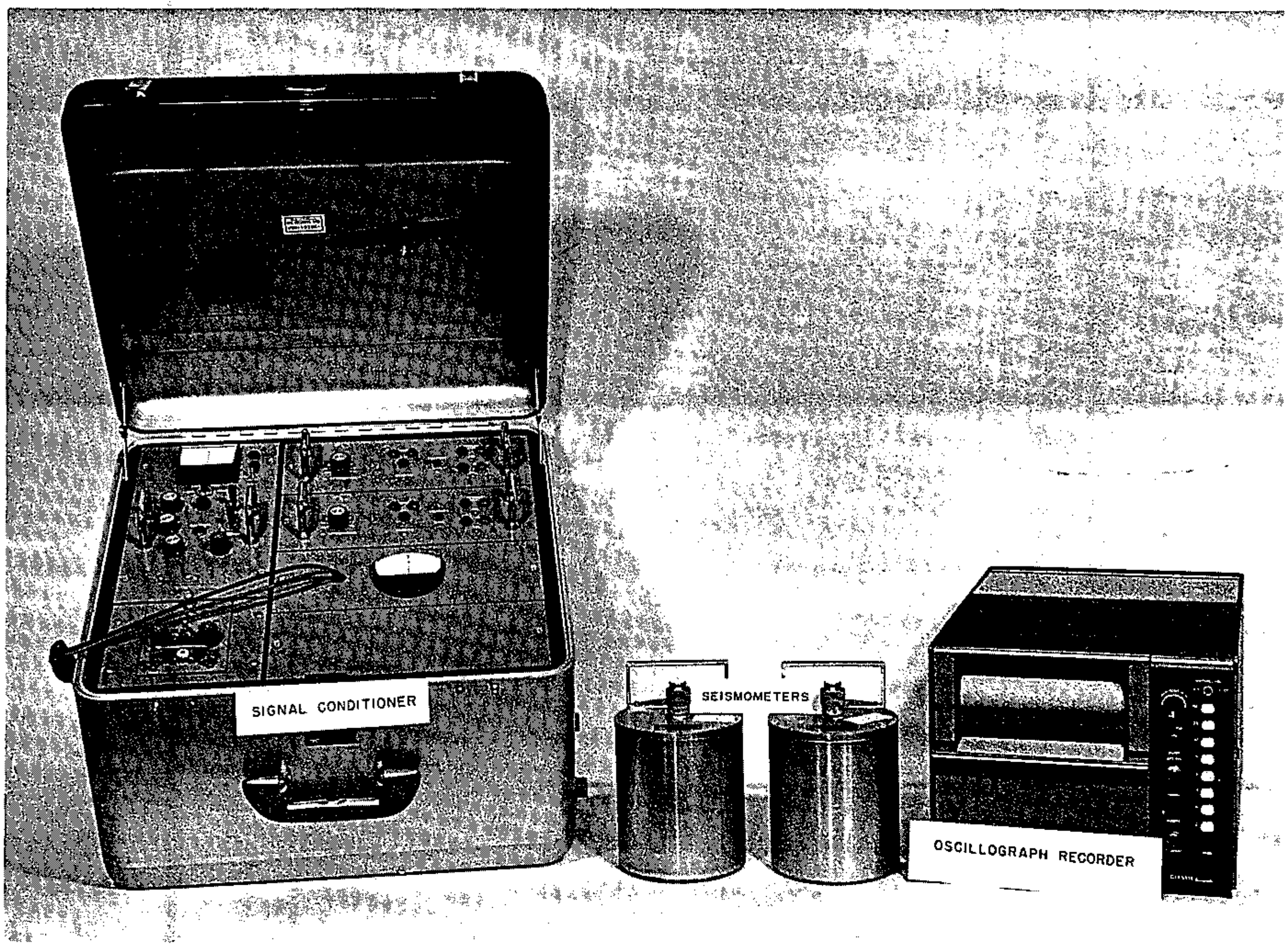


Figure 4



EARTH-BORNE VIBRATIONS
MEASURING EQUIPMENT

NORTH AMERICAN - ROCKWELL VIBRATION SURVEY

Vibration Test Record — Run No. 1

Date: Oct. 29, 1968

Location: NAR metrology hallway (see figure 2)

Vibration Source: Truck crane passage (run#1)

Attenuation: 30 db

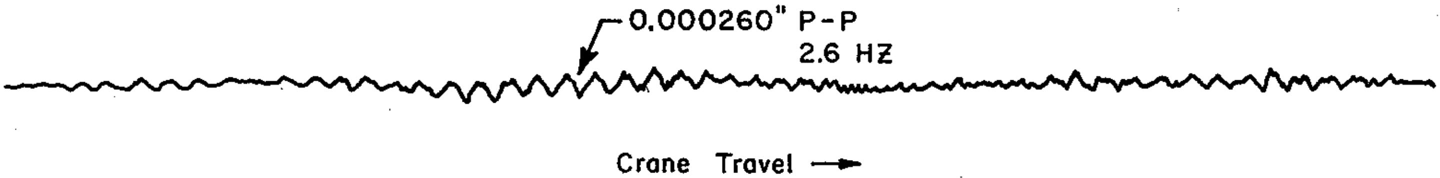


Figure 6

Vibration Test Record — Run No. 2

Date: Oct. 29, 1968

Location: NAR metrology hallway (see figure 2)

Vibration Source: Truck crane passage (run#2)

Attenuation: 30db

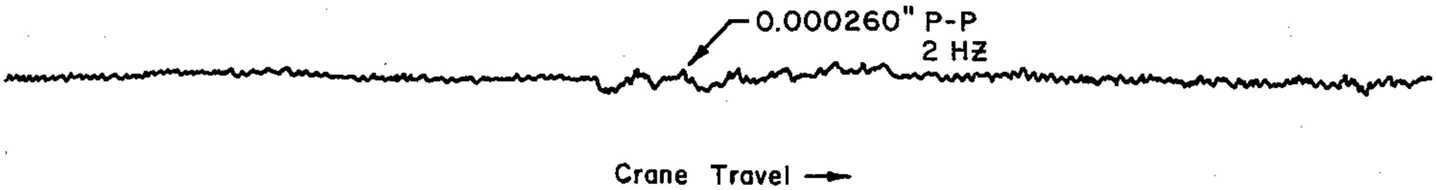


Figure 7

NORTH AMERICAN - ROCKWELL VIBRATION SURVEY

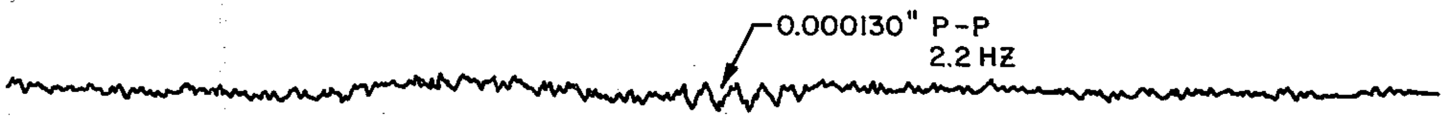
Vibration Test Record — Run No. 3

Date: Oct. 29, 1968

Location: NAR metrology hallway (see figure 2)

Vibration Source: Truck crane passage (run#3)

Attenuation: 24db



Crane Travel ⟶

Figure 8

Vibration Test Record — Run No. 4

Date: Oct. 29, 1968

Location: NAR metrology hallway (see figure 2)

Vibration Source: Truck crane passage (run#4)

Attenuation: 24db

Crane Travel ⟶

Figure 9

NORTH AMERICAN - ROCKWELL VIBRATION SURVEY

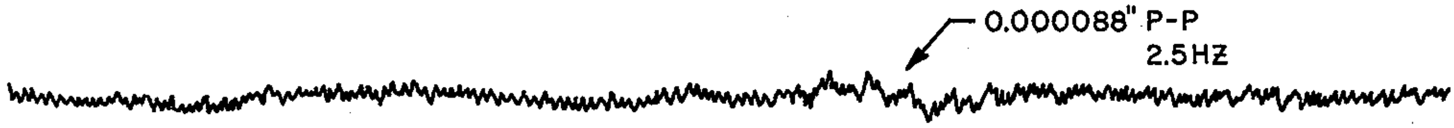
Vibration Test Record — Run No. 6

Date: Oct. 29, 1968

Location: NAR metrology hallway (see figure 2)

Vibration Source: Truck crane passage (run #6)

Attenuation: 18 db



Crane Travel →

Figure 10

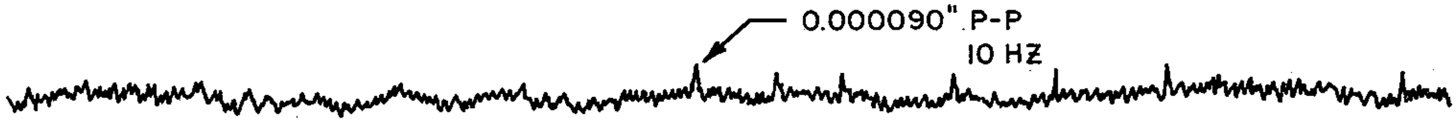
Vibration Test Record — Run No. 7

Date: Oct. 29, 1968

Location: NAR metrology hallway (see figure 2)

Vibration Source: Foot stomping in hallway

Attenuation: 18 db



← Chart Travel

Figure 11

NORTH AMERICAN-ROCKWELL VIBRATION SURVEY

Vibration Test Record   Run No. 8

Date: Oct. 29, 1968

Location: NAR metrology hallway (see figure 2)

Vibration Source: Door slammed in the hallway

Attenuation: 18db

← Chart Travel

Figure 12

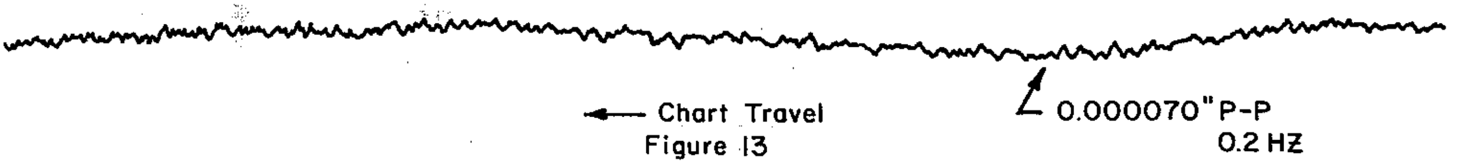
Vibration Test Record   Run No. 10

Date: Oct. 29, 1968

Location: NAR metrology hallway (see figure 2)

Vibration Source: Quiescent period in the hallway

Attenuation: 18 db



← Chart Travel

Figure 13

NORTH AMERICAN - ROCKWELL VIBRATION SURVEY

Vibration Test Record — Run No. 11

Date: Oct. 29, 1968

Location: On the floor of NAR airconditioning mezzanine (see figure 2)

Vibration Source: Airconditioning machinery in operation

Attenuation: 30db

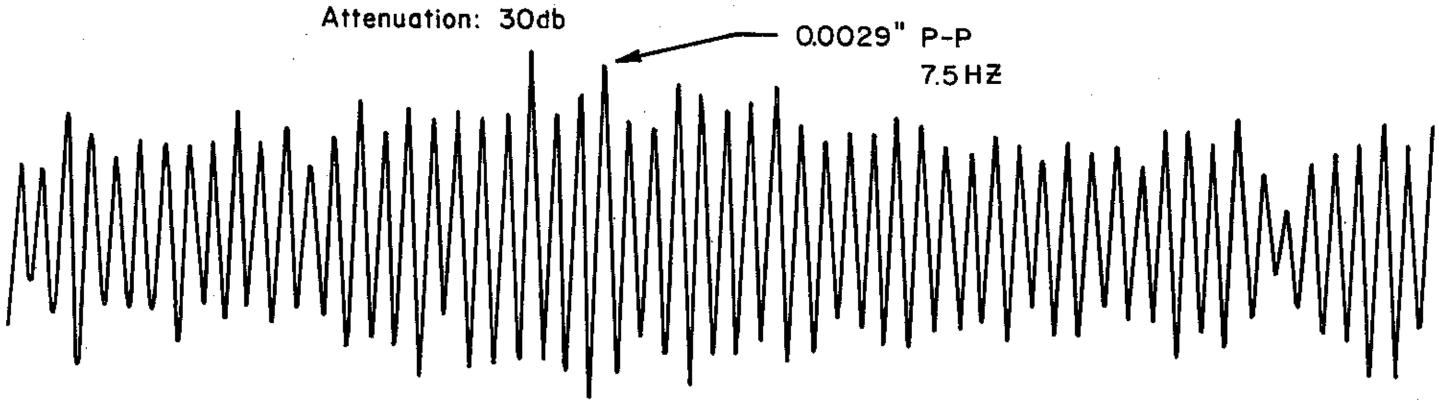


Figure 14

NORTH AMERICAN - ROCKWELL VIBRATION SURVEY

Vibration Test Record Run No. 15A

Date: Oct. 29, 1968

Location: On NAR parking lot 55 feet normal from Imperial Highway curbline (see figure 3)
Vibration Source: Quiescent period

Attenuation: 24 db

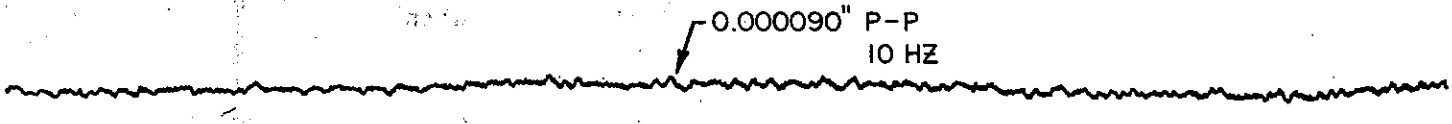


Figure 15

Vibration Test Record Run No. 18

Date: Oct. 29, 1968

Location: Seismometers 5 and 55 feet normal from Imperial Highway curbline (see figure 3).
Vibration Source: Vehicle traffic on Imperial Highway.

Attenuation: 24 db

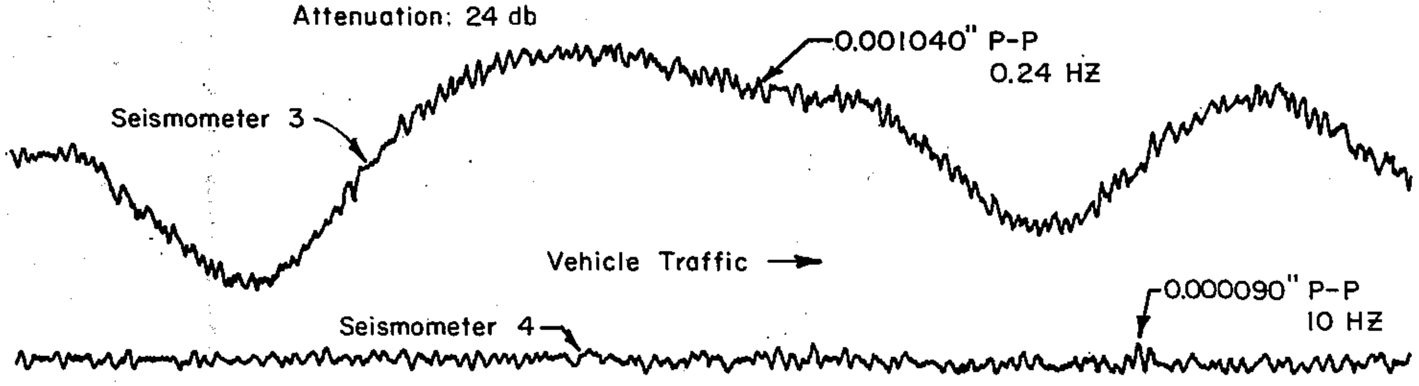


Figure 16

NORTH AMERICAN - ROCKWELL VIBRATION SURVEY

Vibration Test Record — Run No. 30

Date: Oct. 30, 1968

Location: Directly beneath Santa Monica Freeway Viaduct,
1615 Wall Street, Los Angeles, California

Vibration Source: Vehicle Traffic on the freeway viaduct.

Attenuation: 24db

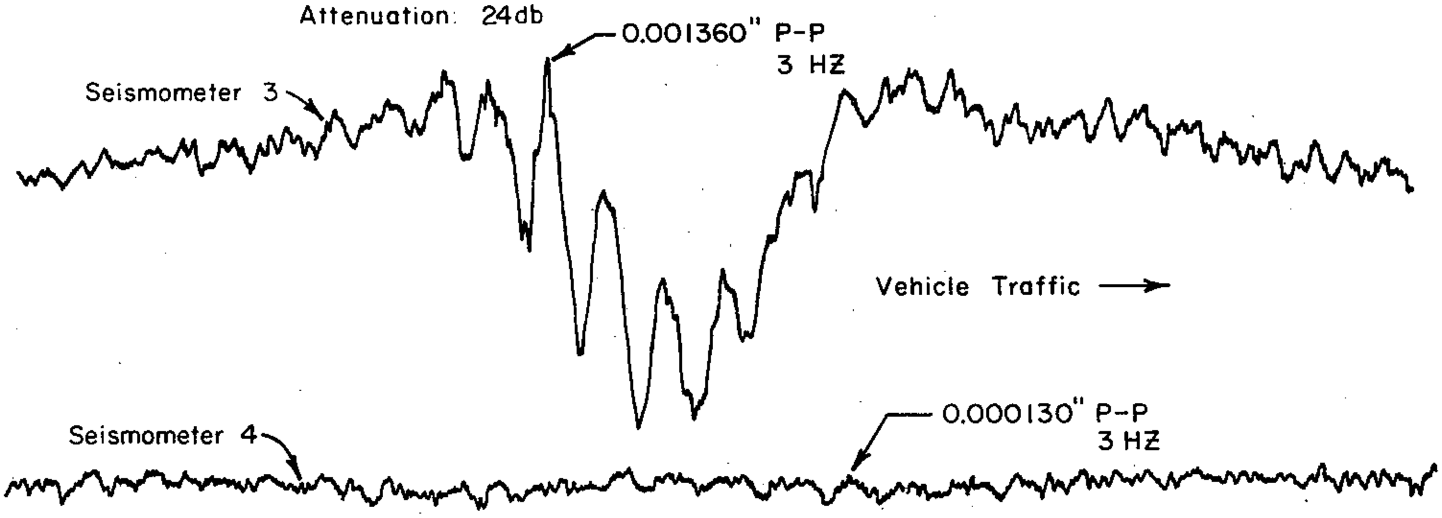


Figure 17

Vibration Test Record — Run No. 41

Date: Oct. 31, 1968

Location: Pomona Freeway construction in the vicinity of Diamond Bar

Vibration Source: Quiescent period

Attenuation: 24db

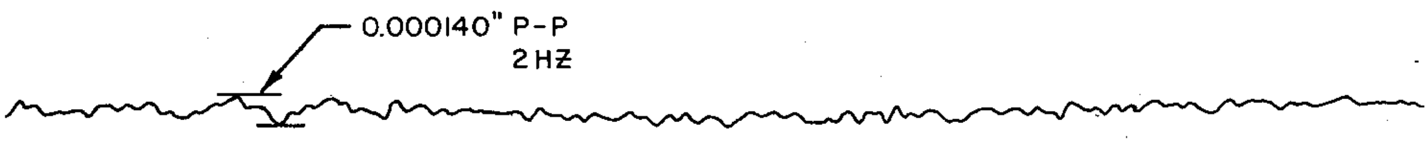


Figure 18

NORTH AMERICAN-ROCKWELL VIBRATION SURVEY

Vibration Test Record — Run No. 47

Date: Oct. 31, 1968

Location: Pomona Freeway contruction in the vicinity of Diamond Bar

Vibration Source: Caterpiller model 651 earth-movers hauling earth fill.

Attenuation: 24db

Figure 19

Vibration Test Record — Run No. 49

Date: Oct. 31, 1968

Location: Pomona Freeway construction in the vicinity of Diamond Bar

Vibration Source: Caterpiller model 651 earth-movers hauling earth fill.

Attenuation: 18db

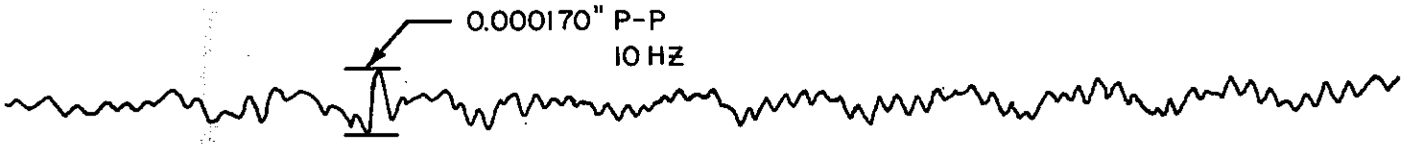


Figure 20

NORTH AMERICAN-ROCKWELL VIBRATION SURVEY

Vibration Test Record — Run No. 57

Date: Oct. 31, 1968

Location: Pomona Freeway construction in the vicinity of Diamond Bar

Vibration Source: 18 inch auger drilling for cast in place concrete pile.

Attenuation: 18 db

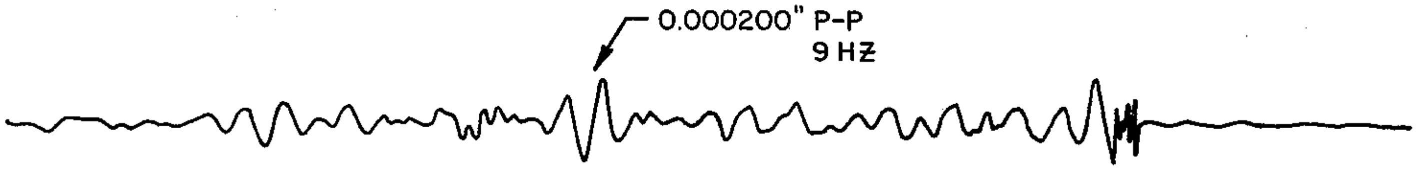


Figure 21

Vibration Test Record — Run No. 61

Date: Oct. 31, 1968

Location: Foothill Freeway construction in the vicinity of Sylmar

Vibration Source: Quiescent period

Attenuation: 24 db

Figure 22

NORTH AMERICAN - ROCKWELL VIBRATION SURVEY

Vibration Test Record Run No. 68

Date: Oct. 31, 1968

Location: Foothill Freeway construction in the vicinity of Sylmar

Vibration Source: Euclid model E-50 (40 yds. capacity) hauling earth fill.

Attenuation: 24 db

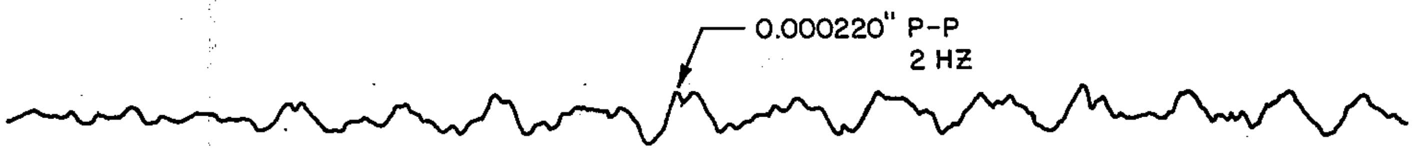


Figure 23

FIGURE 24

NORTH AMERICAN VIBRATION SURVEY

Chart Speed and Calibration Data for the Listed Runs

Run No.	Chart Speed Inches per Sec.	Calibration in Inches per Inch	Calibration in db
1	0.4	0.00176	30
2	0.4	0.00176	30
3	0.4	0.00088	24
4	0.4	0.00088	24
6	0.4	0.00044	18
7	0.4	0.00044	18
8	1.0	0.00044	18
10	1.0	0.00044	18
11	1.0	0.00176	30
15	1.0	0.00176	30
15A	1.0	0.00088	24
18	1.0	0.00088	24
30	1.0	0.00088	24
41	1.0	0.00088	24
47	1.0	0.00088	24
49	1.0	0.00044	18
57	1.0	0.00044	18
61	1.0	0.00088	24
68	1.0	0.00088	24